

REVERSIBLE DATA HIDING (RDH) ALGORITHM FOR .JPG COLOUR IMAGES

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Abstract— This paper discusses about RDH algorithm proposed for colour images of .jpg image format while maintaining the PSNR values high . The proposed algorithm for colour images maintain the visual quality of images. The highest 2 bins of the histogram were selected for data embedding so that histogram equalization can be performed on each plane of the colour image. The side information was embedded along with the message bits in the host plane such the original image is reversible even after embedding and extraction of data in the planes. The proposed algorithm was tested on the sample of 10 images of .jpg format and the results prove that the proposed algorithm preserves the visual quality even after embedding a substantial quality of message bits.

Keywords—.histogram equaization, reversible data hiding

I. INTRODUCTION

Colour Models:

Colour utilized as a part of illustrations depend on a specific model. The model you pick relies upon the scope of colour you require in a realistic and whether it will be yield to screen. There are different colour models accessible. Some of these are:

- Black & white
- Greyscale
- RGB - Red, Green and Blue
- CMYK - Cyan, Magenta, Yellow and Black
- YCbCr
- Lab - Luminance, 'a' & 'b' stand for chrominance
- HSB - Hue, Saturation & Brightness. Other similar models are:
- HSL, where L stands for Lightness,
- HSV, where V stands for 'brightness Value' and
- HCV, where C stands for Chroma and V for Value.
- Indexed
- Web safe

The colour model isn't as usually utilized. It will be shown on screen utilize the RGB or HSB/HSL/HSV colour models. There is additionally the YUV and YCC models which are utilized for TVs. RGB and CYMK are the most well-known colour models utilized for illustrations. RGB is known as the essential colour model. Any gadget that utilizes light to show illustrations eg TVs, film projectors, PC screens, utilized the RGB colour model. At the point when blends of unadulterated red, green and blue are connected, they deliver either Cyan, Fuchsia or Yellow. CMYK is along these lines known as the auxiliary colour model, as it is made from the essential colour model.

RGB

The RGB colour model involves 24 bits for each pixel with 8 bits allocated to red, 8 bits to green and 8 bits to blue. The measure of qualities accessible with 8 bits is 256 (2^8) going from 0-255. In the event that you take a gander at the colour picker in a designs application you will see that R, G and B will each have an esteem going between 0-255. An unadulterated colour has estimation of 255 and no colour has an estimation of 0. The different mixes of immaculate RGB make the accompanying:

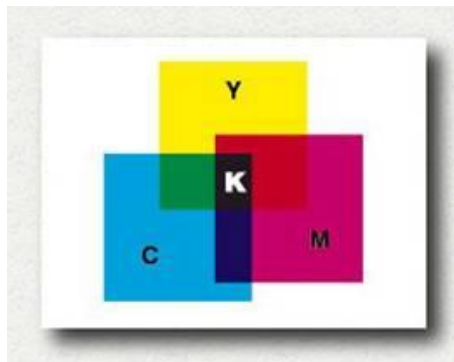
R-255,G-0,B-0	RED	
R-0,G-255,B-0	GREEN	
R-0,G-0,B-255	BLUE	



The 'recorded colour model' is for the most part utilized with the RGB model to diminish document sizes. This is a diminished adaptation of the measure of colour in the realistic and just backings up to 256 colour.

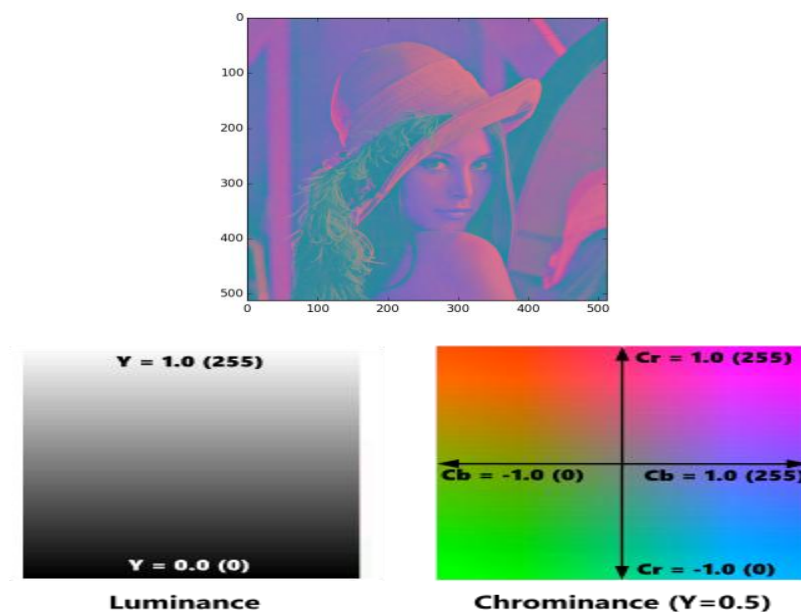
CYMK

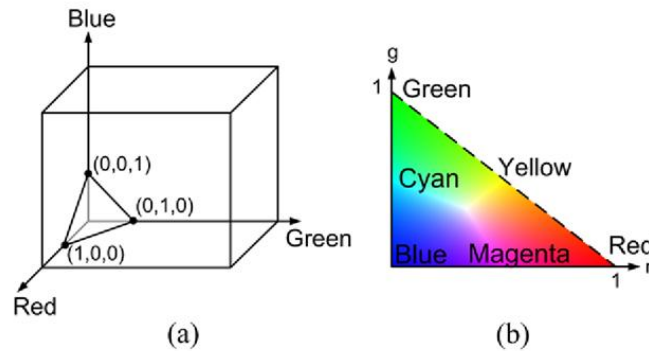
white is pure color whereas black is that the lack of color. black isn't really a color in the slightest degree. after you mix pure cyan, magenta and yellow along you get black. that's what the 'k' stands for - b is reserved for 'blue'. it's for this reason that cmyk is understood because the subtractive color model. as declared earlier, cmyk is employed for medium. after you mix cmy ink along you do not get a pure black, thus black ink must be side.



YCbCr:

YCbCr can be written as $Y C_b C_r$ which is used in video and a part of color image pipeline in digital photography. Where Y stands for luma and C_b, C_r stands for blue difference and red difference chroma components





some of the DIGITAL images formats supported by matlab be

PPM(portable pix map)

TIFF(tagged image file formate)

GIF(graphics interchanged formate)

JPEG(joint photographic experts group)

BMP(windows bit map)

PNG(portable ne2rk graphics)

RDH for colour image is one of the approach where data can be retrieved by without any distortions in the image by maintain the image aspect, RDH for colour image is to embedded a sample of information into the host image (signal) to obtain the reversible image from which the pioneer image can be exactly recovered after extracting the embedded piece of information. The approach of RDH for colour image is practicable in some delicate applications where no permanent change is allowed on the host signal. In the literature, most of the suggested algorithms are for digital images to embed invisible data. To evaluate of the execution of the algorithm we will calculate the aspect metric for the initial image to extract image, in order to find out whether any distortion are occurred are not and by calculating the PSNR we can find out the distortion of the image. In general speaking direct adjustment of image histogram gives less data inserting scope

Although the PSNR of a reversible image developed with a prediction error based algorithm is maintain high, the visual aspect can hardly be improved because more or less distortion has been imported by the inserting operations. For the images acquired with poor illumination, elaborating the visual aspect is more important than maintaining the PSNR value big. To our perfect observation, there is no existing RDH algorithm that implements the task of contrast enhancement so as to improve the visual aspect of host images. So in this study, we aim at inventing a new RDH For colour image algorithm to achieve the property of contrast enhancement instead of just maintaining the PSNR value high. In principle, image contrast enhancement can be achieved by histogram equalization. To perform data inserting and contrast enhancement at the equivalent time, the suggested algorithm is performed by reorganizing the histogram of pixel values. primarily, the 2 peaks (i.e. the biggest 2 bins) in the histogram are create out. 2 adjoining bins are separation depending on the bins between the peaks are undisturbed until the outer bins are shifted outwards. To increase the inserting capacity, the highest 2 bins in the altered histogram can be in addition chosen to be separation, and so on until adequate contrast enhancement effect is achieved. To avoid the overflows and underflows due to histogram modification, the bounding pixel values are pre-processed and a location-map is developed to recall their locations. For the restoration of the initial image, the location-map is embedded into the host image, well-organized with the information bits and other side information. So blind data extraction and entire rebuilding of the initial image are both implemented. The suggested algorithm was applied to set of images to demonstrate its efficiency. To our best knowledge, it is the first algorithm that accomplish image contrast enhancement by RDH. achieve, the calculation results show that the visual aspect can be sustained after a noticeable amount of information bits (message bits) have been embedded into the contrast enhancement images. The rest of the letter is organized as follows. Section II presents the details of the suggested RDH algorithm featured by contrast enhancement. The experiment all results are given in Section III. Finally, a conclusion is drawn in Section IV.

II. RDH ALGORITHM WITH CONTRAST ENHANCEMENT.

A. Data Inserting by Histogram Modification.

The algorithm to be presented is primarily for colour images. An 8-bit colour image I , the image histogram can be estimated by counting the pixels with plane values J for $j \in \{0, 1, \dots, 254, 255\}$. We use h_I to denote the image histogram so that $h_I(J)$ exhibit the no of pixels with a value J . Suppose I consists of N different pixel values. Then there are N non

empty bins in hI , from which the 2 peaks (i.e. the biggest 2 bins) are chosen and the corresponding smaller and bigger values are denoted by IS and IR , respectively. For a pixel counted in hI with value i , data inserting is performed by

$$I' = \begin{cases} i - 1, & \text{for } i < IS \\ IS - bk & \text{for } i = IS \\ i, & \text{for } IS < i < IR \\ IR + bk, & \text{for } i = IR \\ i + 1 & \text{for } i > IR \end{cases} \quad (1)$$

where i' is the altered pixel value, and bk is the k -th information bit (0 or 1) to be masked. By applying Eq. (1) to every pixel counted in totally hI (IS)+ hI (IR) binary values are embedded. Given that there is no bounding value (0 or 255) in (otherwise pre-process is needed), there is $N+2$ bins in the altered histogram. That is, the bins between the 2 peaks are unaffected while the outer ones are transfer outward so that each of the peaks can be separation into 2 adjoining bins (i.e $IS-1$ and IS , IR and $IR+1$, respectively). The peak values IS and IR need to be provided to extract the embedded data. One way to keep them is to exclude 16 pixels in I from histogram computing. The least significant bits(LSB) of those pixels are collected and included in the binary values to be masked. After applying Eq.(1)to each pixel counted in for data inserting, the values of IS and IR (each with 8 bits) are used to replace the LSBs of the 16 removed pixels by bitwise operation. To extract the embedded data, the peak values need to be retrieved and the histogram of the reversible image I' is estimated excluding the 16 pixels above. Then the following operation is performed on any pixel counted in the histogram m and with the value of $IS - 1$, IS , IR or $IR + 1$:

$$bk' = \begin{cases} 1 & \text{if } i' = IS - 1 \\ 0 & \text{if } i' = IS \\ 0, & \text{if } i' = IR \\ 1, & \text{if } i' = IR + 1, \end{cases} \quad (2)$$

where bk' is the K -th binary value extracted from the reversible image planes I' . The extraction operations are performed in the same order as that of the inserting operations. According to Eq.(1), the following operation is performed one very pixel counted in the histogram to recover its initial value:

$$i = \begin{cases} i' + 1 & \text{for } i' < IS - 1 \\ IS & \text{for } i' = IS - 1 \text{ or } i' = IS \\ IR, & \text{for } i' = IR \text{ or } i' = ir + 1 \\ i' - 1, & \text{for } i' > IR + 1 \end{cases} \quad (3)$$

The initial LSBs of 16 removed pixels are obtained from the extracted binary values. The removed pixels can be restored by writing them back so as to recover the initial image.

B. Pre-Process for Complete Reformation

In the above algorithm, it is required that all pixels counted in hI are with in $\{1, \dots, 254\}$. If there is any bounding pixel value (0 or 255), overflow or underflow will be caused by histogram shifting. To avert it, the histogram needs to be pre-processed prior to the histogram modification operations. Specifically, the pixel values of 0 and 255 are altered to 1 and 254, appropriately. So, no overflow or underflow will be caused because the possible change of each pixel value is ± 1 . To recall the pre-processed pixels, a location-map with the equal size as the initial image is developed by assigning 1 to the location of a altered pixel, and 0 to that of an unchanged one (including the 16 left pixels). The location-map can be pre computed and included into the binary values to be masked. In the restoration process, it is obtained from the data extracted from the reversible image so that the pixels altered in the pre-process can be identified .By restoring the initial values of those pixels accordingly, the initial image plane can be completely recovered

C. Contrast Enhancement

In Section II-A, each of the 2 peaks in the histogram is separation into 2 adjoining bins with the same heights because the numbers of 0s and 1s in the information bits are appropriate to be almost equal. To increment the hiding capacity, the highest 2 bins in the altered histogram are further chosen to be separation by applying Eq. (1) to all pixels estimated in the histogram. The procedure can be repeated by separating each of the 2 peaks into 2 adjacent bins with the same heights to attain the histogram equalization effect. In this approach, data inserting and contrast enhancement are simultaneously performed. Given that the couple of the histogram peaks to be separation is ,the range of pixel values from 0 to are added by while the pixels from to 255 are subtracted by in the pre-process (noting L is a positive integer). A location-map is developed by select 1s to the altered pixels, and 0s to the others. The location-map can be pre-computed and compressed to be firstly inserted into the host image. The value of ,the content of the restricted location map, and the earlier peak values, in contrary, are embedded with the last 2 peaks to be separation, whose values are stored in the LSBs of the 16 removed pixels. In the extraction process, the last separation peak values are retrieved and the data embedded with them are extracted with Eq. (2). After restoring the histogram with Eq.(3), the data embedded with the earlier separation peaks can also be extracted by processing them pair by pair. At last, the location-map is obtained from the withdraw data to determine the pixel values altered in the pre-process.

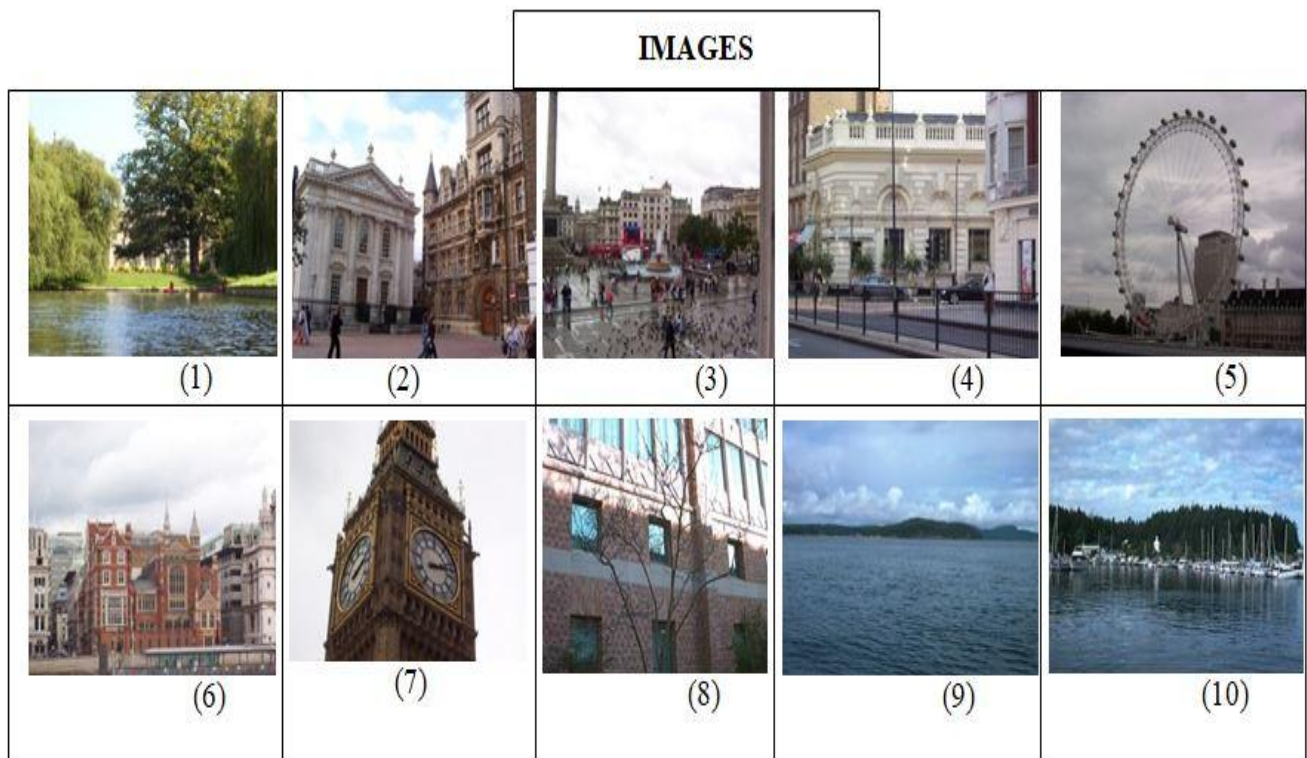
D. Procedure of the suggested Algorithm

The procedure of the suggested algorithm is shown in Fig. 1. Given that entirely L pairs of histogram bins are to be separated for data inserting, the inserting procedure includes the following steps:

- 1) Pre-process: The pixels in the range of $[0, L-1]$ and $[256-L, 255]$ are processed as mentioned in Section II-C excluding the first 16 pixels in the last row. A location-map is developed to note the locations of those pixels and abbreviate by the JBIG2 standard to cut its length.
- 2) The image histogram is estimated without counting the first 16 pixels in the last row for each individual plane of colour image.
- 3) Inserting: The 2 peaks (i.e. the biggest 2 bins) in the histogram are separation for data inserting by applying Eq.(1) of rdh algorithm for color image to every pixel compute in the histogram. Then the 2 peaks in the altered histogram are chosen to be separation, and soon until L pairs are separation. The bit stream of the compressed location-map is embedded before the information bits (binary values). The value of, the length of the compressed location map, the LSBs collected from the 16 removed pixels, and the earlier peak values are embedded with the last 2 peaks to be separation.
- 4) The finally separation peak values are used to replace the LSBs of the 16 removed pixels form each plane to from reversible image.

The extraction and restoration process include the following steps:

- 1) The LSBs of the 16 removed pixels are retrieved so that the values of the last 2 separation peaks are known.
- 2) The data embedded with the last 2 separation peaks are extracted by using Eq. (2) of rdh algorithm for each plane of color image so that the value of, the length of the coagulated location-map, the initial LSBs of 16 removed pixels, and the earlier separation peak values are known. Then the restoration operations are carried out by processing all pixels except the 16 removed ones with Eq.(3) of rdh algorithm for color image. The process of extraction and restoration is repeated until all of the separation peaks are restored and the data embedded with them are extracted.
- 3) The reduced location-map is attain from the extracted binary values and decompressed to the initial size.
- 4) With the decompressed map, those pixels altered in pre process are identified. With them, a pixel value is deduct L by if it is less than 128, or increased by L otherwise. To comply with this rule, the maximum value of is 64 to avoid ambiguity. At last, the initial image is recovered by writing back the initial LSBs of 16 removed pixels.



Block diagram:

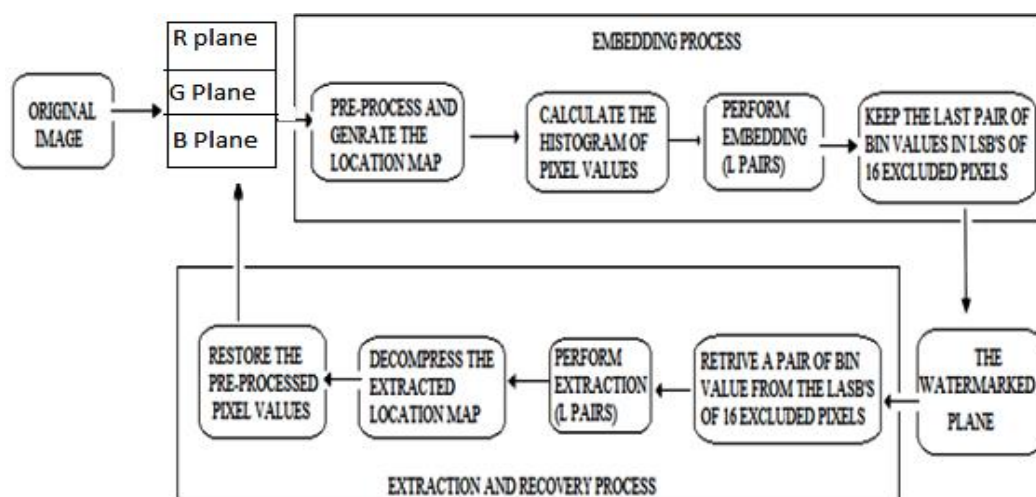
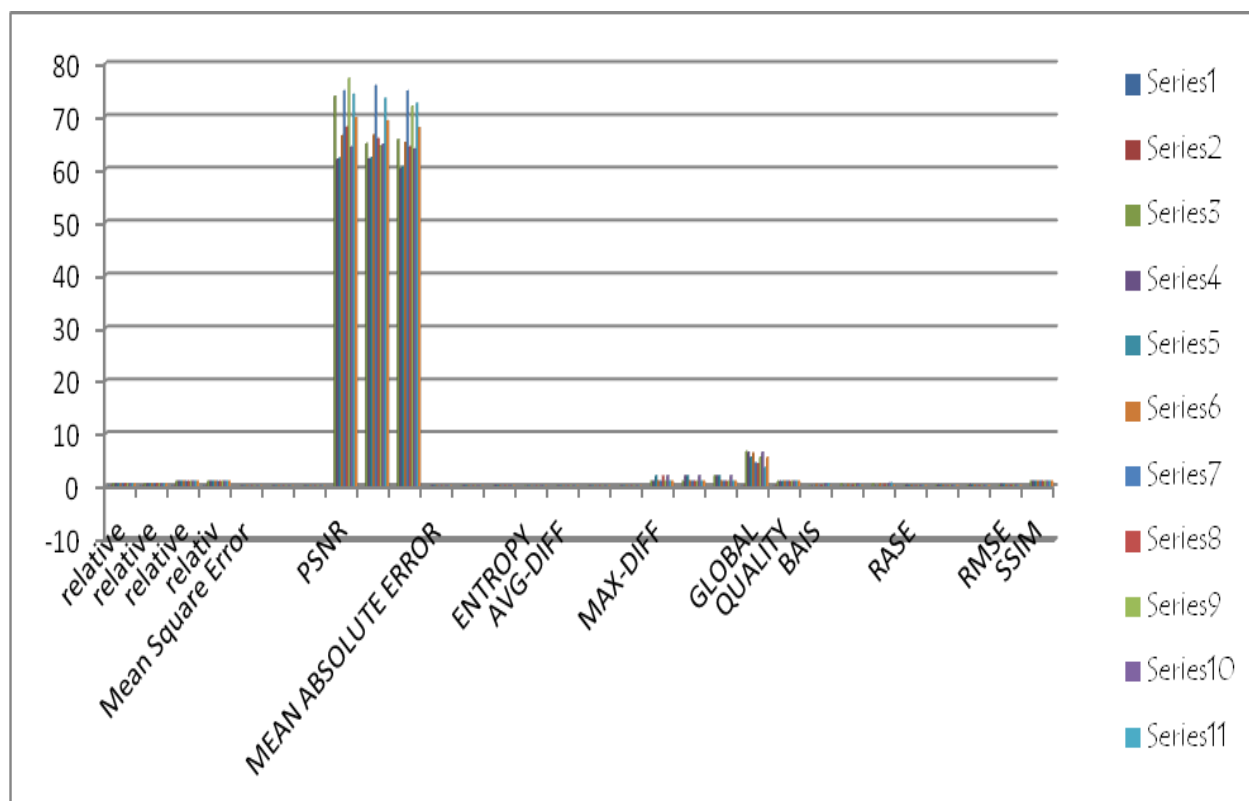


Figure 1 RDH ALGORITHM FOR COLOUR IMAGES

TABULAR COLOUM:

IMAGE			1	2	3	4	5	6	7	8	9	10
relative	entropy	error	0.5014	0.5031	0.5054	0.5003	0.5002	0.5019	0.5007	0.5073	0.5001	0.5005
relative	contrast	error	0.5065	0.5178	0.5144	0.5048	0.5002	0.5049	0.5013	0.5094	0.5005	0.5022
relative	an brightn	error	0.9997	0.9991	0.9993	0.9998	1	0.9998	0.9999	0.9995	1	0.9999
relativ	structural	error	0.9992	0.9985	0.9985	0.9991	0.9998	0.9991	0.9993	0.9989	0.9997	0.9994
Mean Square Error			0.0027	0.0427	0.0401	0.0152	0.0022	0.0105	0.0013	0.0247	0.0025	0.0069
			0.0213	0.0417	0.0395	0.0147	0.0017	0.0173	0.0239	0.0222	0.003	0.0079
			0.0181	0.0648	0.0589	0.0204	0.0022	0.0245	0.0042	0.027	0.0037	0.0107
PSNR			73.8113	61.8276	62.1003	66.3122	74.7892	67.9065	77.1478	64.2124	74.1814	69.7331
			64.8445	61.9345	62.1651	66.462	75.7767	65.7543	64.3547	64.6694	73.3535	69.1706
			65.5475	60.0135	60.4318	65.0299	74.7586	64.2345	71.8686	63.8125	72.4307	67.8284
MEAN ABSOLUTE ERROR			0.0078	0.128	0.1201	0.0456	0.0029	0.0314	0.0037	0.073	0.0065	0.0109
			0.0638	0.1241	0.1178	0.0441	0.0021	0.0519	0.0712	0.065	0.0062	0.0184
			0.0523	0.1935	0.1757	0.0612	0.001	0.0736	0.0121	0.0797	0.0107	0.0302
ENTROPY			0.0158	0.0345	0.0598	0.0036	0.0024	0.0215	0.0074	0.0808	0.0014	0.0059
AVG-DIFF			0.0025	0.0427	0.04	0.0152	-2.17E-04	0.0105	0.0012	0.0241	0.0018	3.76E-04
			0.0213	0.0412	0.0391	0.0147	-3.15E-04	0.0173	0.0236	0.0212	0.0012	0.0044
			0.0168	0.0642	0.0583	0.0204	-0.0015	0.0245	0.0038	0.0262	0.0034	0.0094
MAX-DIFF			1	1	2	1	1	2	1	2	1	1
			1	2	2	1	1	1	1	2	1	1
			2	2	2	1	1	1	1	2	1	1
GLOBAL	CONTRAST	FACTOR	6.5892	6.4539	5.5039	6.316	4.4417	4.2428	5.5615	6.4198	3.5561	5.5055
QUALITY	INDEX	FACTOR	0.9875	0.9726	0.9509	0.999	0.9998	0.9803	0.9956	0.9945	0.9998	0.9997
BAIS			0.0624	0.0009	0.0008	0.3388	-0.0484	0.1775	0.0221	0.542	0.53	0.0113
			0.505	0.001	0.0008	0.3401	-0.073	0.3106	0.4548	0.4817	0.2581	0.104
			0.5133	0.0015	0.0012	0.4703	-0.3394	0.4448	0.0746	0.5861	0.6262	0.1906
RASE			0.0747	0.257	0.2285	0.1587	0.0598	0.1004	0.0375	0.2043	0.0828	0.1436
			0.2002	0.2724	0.2365	0.1621	0.0555	0.1364	0.172	0.195	0.0705	0.1214
			0.2379	0.3431	0.2886	0.1902	0.0609	0.164	0.0736	0.2125	0.0649	0.1215
RMSE			0.2035	0.3856	0.3716	0.2243	0.0448	0.2288	0.1702	0.2697	0.0883	0.1408
SSIM			1	0.9999	0.9998	1	1	0.9999	1	0.9999	1	1

Graph:



III. EXPERIMENTAL RESULTS

In this MODIS AIRBORNE SIMULATOR, GALLERY AND DATA SET test images with size of 512 *512 were employed , here a colour image of .jpg image is consider and planes cascaded and each individual plane is embedded with data with 100 binary bits of 0 and 1 as of information bits . The information bits to be masked can be any string of binary values in which the no of 0's and 1's are almost equal . Hiding increase by separation of histogram. pure restoration of embedded data is found in all the set of 10 images , the following images taken were in which data is invisible in the contrast enhanced images more histogram peaks were separation ,ore data is embedded and contrast is enhanced by preserving the visual image aspect. The psnr values the relative contrast error, relative entropy error, relative mean brightness error and relative structural similarity, mean square error, mean absolute error, entropy, average difference , maximum difference, quality index factor ,root mean square error ,structure similarity index measure are estimated , to find an changes occurred in between initial image to the contrast enhanced image and analysis takes place based on the image aspect. The mean square is defined as the square of the difference between the pixel values of initial image and the stego image. RMSE(Root mean square error) is estimated by getting the square root of mean square error. Structural similarity index (SSIM) index aspect assessment index is based on the calculation of three terms luminance, contrast and structure. An image aspect metric that estimate the visual impact of 3 characteristics of an image. Entropy is a degree of randomness that can be used to describe the composition of the input image. Contrast in image processing is usually characterize as a ratio among the darkest and the brightest spots of an image. For each image the above aspect metric is calculate and analyzed , from table 1 show the result of the image taken for consideration , by comparing with thee metrics the image aspect can be preserved certain amount of data is masked , beyond the degradation image while happen

CONCLUSION

In this paper we a new RDH algorithm for colour images has been suggested , general the main theme in maintaing the 2 peaks (biggest 2 bins) in the histogram are chosen for data inserting in orderly repeating the process leads to histogram equalization. In this paper we have shown data embedded into planes of a colour images preserved by the algorithm and hence the initial tested image can be recovered. Elaborating the algorithm applying it to medical and satellite images for better aspect for further work.

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